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ABSTRACT

This brochure provides information about Project 2061's Benchmarks for Science Literacy. It includes background information on the development of Benchmarks, a rationale for developing scientific literacy in the general public, a list of those individuals and groups who could benefit most from using Benchmarks, a comparison of Benchmarks and the National Science Education Standards, implications for assessment based on Benchmarks, the availability of Benchmarks, and a summary of the Project 2061 reform strategy. (DDR)

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Project 2061

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Benchmarks for Science Literacy *A Tool for Curriculum Reform*

BENCHMARKS FOR SCIENCE LITERACY EMERGED from more than three years of work by teams of teachers at Project 2061's six School-District Centers in collaboration with scientists, university consultants, and Project 2061 staff. It reflects the critical input of more than 1300 individuals who reviewed the draft document. Published in 1993 by Oxford University Press, *Benchmarks for Science Literacy* is the Project 2061 statement of what all students should know or be able to do in science, mathematics, and technology by the end of grades 2, 5, 8, and 12. The recommendations

at each
grade level
suggest
reasonable
progress
toward the
science

literacy goals expressed in the Project's 1989 report *Science for All Americans (SFAA)*. By translating the literacy goals of *SFAA* into learning expectations, *Benchmarks* can help educators decide what to include in (or exclude from) a core curriculum, what order to teach it in, and why.

Designing a Curriculum

Benchmarks is part of a coordinated set of reform tools. It is very different from a curriculum, a curriculum framework, or a plan for a curriculum. Instead, it is a tool educators can use to design a curriculum that makes sense to them, suits the specific needs and interests of their students, and meets the goals for science literacy recommended in *SFAA*. *Benchmarks* does not advocate any particular curriculum design—in fact, it encourages greater curriculum diversity than is common today. In addition, *Benchmarks*:

- describes levels of understanding and ability that all students are expected to reach on the way to becoming science literate,
- concentrates on the common core of learning that contributes to the science literacy of all students while acknowledging that most students have interests, abilities, and ambitions that go beyond that common core and some have learning difficulties that must be taken into account,

- avoids technological language used for its own sake, recognizing that the number of technical terms that most adults must understand is relatively small,
- is informed by research on students' understanding and learning particularly as it relates to the selection and grade placement of specific benchmarks, and
- encourages educators to recognize the interconnectedness of knowledge and to build these important connections into their curriculum units and materials.

Using *Benchmarks*

Who should use *Benchmarks* and how? Together, *Benchmarks* and *Science for All Americans* can be used by educators and curriculum developers for a variety of purposes:

- Study groups of teachers, administrators, school board members, parents, interested citizens, and, whenever possible, scientists, engineers, and mathematicians can use *SFAA* to explore the concept of science literacy and its implications for instruction.
- Cross-grade, cross-subject committees of teachers and curriculum specialists can use *Benchmarks* and *SFAA* to gauge how well a specific K-12 curriculum or curriculum framework promotes science literacy.
- School districts can consult the clear goals and flexible guidelines in *Benchmarks* and *SFAA* to come up with effective ways of promoting science literacy among their students.
- Curriculum designers, including school-district teams, can use *Benchmarks* to inform the design and construction of curricula for science literacy.
- Developers of instructional materials can use *Benchmarks* and *SFAA* to guide the creation of materials to support the work of teachers who are trying to foster science literacy for all students and to judge how well existing instructional resources contribute to progress toward science literacy.
- Test writers can use *Benchmarks* to develop grade-level materials and techniques for assessing student progress toward science literacy.

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- Other reform efforts—including the State and Urban Systemic Initiatives funded by the National Science Foundation, The Eisenhower Science and Mathematics Initiatives—may find *Benchmarks* useful in supporting their work.

- Universities and colleges that prepare teachers can use *SFAA* to explore the concept of science literacy and *Benchmarks* to raise issues closer to the realities of curriculum and instruction.

- Researchers can refer to Project tools to identify important topics for investigation, for example, studies on the grade-level placement of benchmarks, effective ways to group benchmarks into instruction units, how to assess student progress toward science literacy, and how to evaluate learning materials and techniques.

Individuals can use *Benchmarks* and *SFAA* to increase their knowledge of science, mathematics, and technology and to discern connections among and within them.

Benchmarks and National Standards

Where they address common areas, the National Research Council's draft *National Science Education Standards (NSES)* and Project 2061's *Benchmarks for Science Literacy* are highly consistent. In fact, the National Research Council relied heavily on *Benchmarks* in drafting its standards as stated in the *NSES*' introduction:

"The many individuals who have developed the content standards sections of the *National Science Education Standards* have drawn extensively on and have made independent use and interpretation of the statements of what all students should know and be able to do that are published in *Science for All Americans* and *Benchmarks for Science Literacy*. The National Research Council of the National Academy of Sciences gratefully acknowledges its indebtedness to that seminal work by the American Association for the Advancement of Science's Project 2061 and believes that use of *Benchmarks for Science Literacy* by the state framework committees, school district curriculum committees, and developers of

instructional and assessment materials complies fully with the spirit of the content standards presented in this draft." (draft *NSES*, p. I-2)

Both visions of science literacy emphasize understanding of ideas central to science literacy over memorization of vocabulary. In most cases, *Benchmarks* and the draft standards place ideas in the same grade ranges.

The *NSES* includes recommendations on teaching and assessment practices, school science programs, and the overall educational system. These and other topics are being addressed by Project 2061 in a dozen concept papers that will be synthesized into a single report, *Blueprints for Reform*, to be published in 1997. *Benchmarks* is organized by content areas with grade ranges (K-2, 3-5, 6-8, 9-12) as sub-sections, while the *NSES* draft is organized by grade-range (K-4, 5-8, 9-12) with content areas cycling through each. The *NSES* draft treats some topics—scientific inquiry and the history of science, for example—somewhat differently than *Benchmarks* does, and covers somewhat less technology.

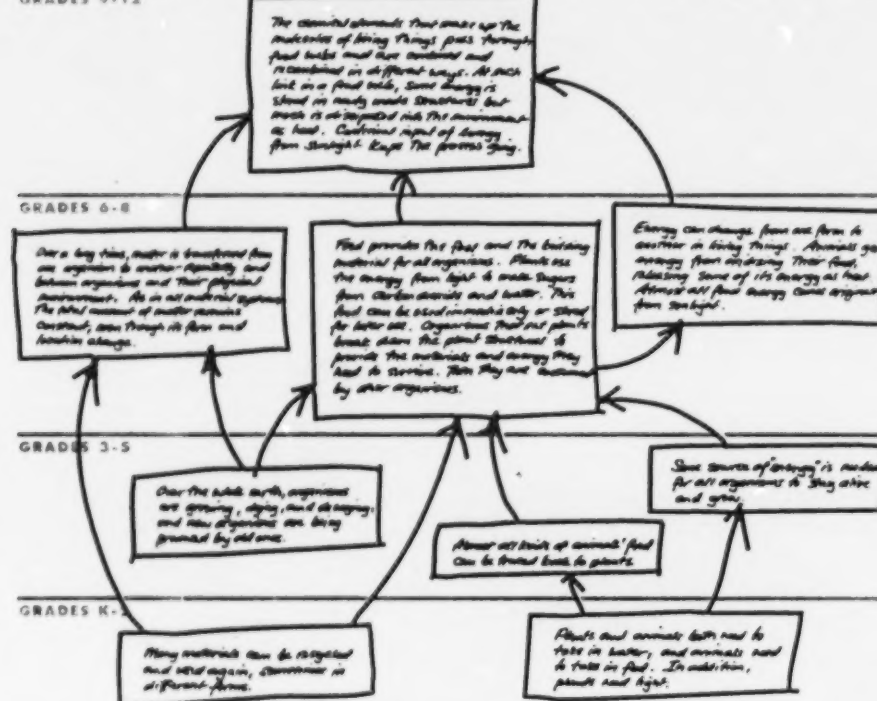
Both reports represent years of work by experts in science and education; the extensive overlap between the documents signifies an informed consensus on what is important in science. Project 2061 has prepared a detailed analysis of the correspondences between *NSES* and *Benchmarks* which will be included in the professional development portion of *Resources for Science Literacy*, a Project 2061 reform tool described below.

Benchmarks and Assessment

Assessment, like good instruction, requires students to use knowledge in meaningful contexts. *Benchmarks* specifies the knowledge and skills that students should be able to use by the end of grades 2, 5, 8, and 12. Thus students should be assessed on their ability to draw on what they have learned to explain phenomena, think critically, and make informed decisions. Rather than using individual benchmarks as isolated test questions, assessment that is compatible with *Benchmarks* would employ contexts that

Flow of Matter and Energy Partial Map

GRADES 9-12



A "strand-map" shows connections among benchmarks leading to a particular science literacy goal.

cut across a variety of benchmarks, requiring students to apply their knowledge and thinking skills in novel settings.

Benchmarks on Disk

Benchmarks on Disk, available in MS-DOS, Windows and Macintosh versions, is the software version of the *Benchmarks* book. It allows users to browse through the entire text of *Benchmarks*, search for particular text words, quickly refer to other sections of the text related to the benchmarks at hand, and consult the research base that influenced the content and grade-level placement of the benchmarks. Users can assemble and print sets of related benchmarks by grade level.

The disk contains several features not available in the book, including benchmarks strands that

trace student progress toward particular adult science literacy goals.

The Project 2061 Reform Strategy

Project 2061 calls for systemic reform of K-12 education to promote science literacy for all students. Rather than create a curriculum for others to adopt, Project 2061 intends to foster diversity and local creativity by designing tools for educators to use in developing their own curriculum. *Science for All Americans*, *Benchmarks for Science Literacy*, and *Benchmarks on Disk* were the first such tools. Forthcoming reform tools will include the following:

- *Resources for Science Literacy* will be a two-part computer based tool to help educators identify and analyze curriculum resources that promote science literacy goals. *Resources for Science Literacy: Professional Development* will contain aids for teachers who want to enhance their understanding of science literacy and their ability to make sound decisions about curriculum materials.

Resources for Science Literacy: Curriculum Materials will provide information about instructional resources and materials that promote science literacy.

- *Designs for Science Literacy*, a handbook for conceptualizing curricula that meet *SFAA* and *Benchmarks* standards, will set out design principles for configuring such curricula. It will also present some alternative curriculum models to illustrate possibilities.

- *Blueprints for Reform* will suggest strategies for systemic reform and describe how various aspects of the educational system—assessment, teacher education, school organization, etc.—need to change in order to accommodate new curricula successfully.

Eventually, all of these tools will be pulled together by a computer-based curriculum-design system for the construction and management of local, K-12, cross-subject curricula for science literacy.

About Project 2061

Project 2061 of the American Association for the Advancement of Science is a long-term initiative to reform K-12 education nationwide so that all high-school graduates are science literate. Its 1989 report, *Science for All Americans (SFAA)*, outlined what all high-school graduates should know and be able to do in science, mathematics, and technology. Project 2061 is now creating a coordinated set of reform tools to help educators meet those goals in their own districts. Working with six school-district teams of teachers and administrators, Project 2061 has developed *Benchmarks for Science Literacy*, a curriculum design tool that translates the literacy goals of *SFAA* into expectations for the ends of grades 2, 5, 8, and 12.

SFAA and *Benchmarks* will soon be joined by *Resources for Science Literacy*, a computer-based tool to help educators improve their own understanding of science literacy and identify and evaluate instructional materials to help students make progress towards it; *Designs for Science Literacy*, a handbook to help educators take a systematic design approach to planning a K-12 curriculum; and *Blueprints for Reform*, recommendations for how various aspects of the K-12 education system must change to accommodate necessary curriculum reforms. Eventually, all of these tools will be pulled together by a computer-based, interactive, multimedia curriculum-design and resource system.

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